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WATER SUPPLY AND WATER QUALITY CONTROL STUDY SOUTH BERRENDO AND BRADY RANCH RESERVOIRS RIO HONDO-RIO FELIX SUBBASINS, NEW MEXICO

Federal Water Pollution Control Administration
Dallas, Texas

February 1967

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WATER SUPPLY AND WATER QUALITY CONTROL STUDY SOUTH BERRENDO AND BRADY RANCH RESERVOIRS RIO HONDO-RIO FELIX SUBBASINS, NEW MEXICO

Study of Needs and Value of Storage for Municipal and Industrial Water Supply and Water Quality Control

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UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
South Central Region
Dallas, Texas
FEBRUARY 1969

WATER SUPPLY AND

WATER QUALITY CONTROL STUDY

SOUTH BERRENDO AND BRADY RANCH RESERVOIRS

RIO HONDO-RIO FELIX SUBBASINS, NEW MEXICO

Abstract

A survey has been made which discloses a future need for municipal and industrial water supplies in the city of Roswell, New Mexico. There is no foreseeable need for storage for water quality control purposes in the project reservoirs. These conclusions are based on results of economic and demographic studies.

Prepared for

DEPARTMENT OF THE ARMY

U.S. Army Engineer District

Albuquerque, New Mexico

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
South Central Region
Dallas, Texas

FEBRUARY 1967

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I. INTRODUCTION

Request and Authority

In a letter dated February 3, 1964, the U.S. Army Engineer District, Albuquerque, New Mexico, requested that the Public Health Service investigate and report on the need for and value of storage for municipal, industrial, and water quality control purposes in the Rio Hondo and Rio Felix subbasins, New Mexico.

The water supply portion of this study was made in accordance with the Memorandum of Agreement, dated November 4, 1958, between the Department of the Army and the Department of Health, Education, and Welfare relative to the Water Supply Act of 1958, as amended (43 U.S.C. 390b). The water quality control aspects are considered under authority of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.). Responsibility for these activities was transferred from the Department of Health, Education, and Welfare to the Department of the Interior by Reorganization Plan No. 2 of 1966, effective May 10, 1966.

Purpose and Scope

This study was made to examine present water use in the study basins and to determine future municipal and industrial water requirements to the year 2070; to evaluate existing and potential water resources in the area to meet these needs and, if storage in the proposed projects for this purpose is needed, determine the value thereof; to examine the probable effects of present and future waste flow to the year 2070 on the quality of the receiving stream; and to determine if dilution releases from the proposed reservoirs are required for water quality control and, if so, evaluate the value of storage for this purpose. The study basins are the Rio Hondo and Rio Felix which are encompassed almost entirely by Chaves and Lincoln Counties in southeastern New Mexico.

Acknowledgments

The cooperation of many persons and agencies is gratefully acknowledged. Special appreciation is expressed to the following:

U.S. Army Engineer District, Albuquerque, New Mexico
New Mexico Department of Public Health, Santa Fe, New Mexico
State Engineer's Office, Santa Fe, New Mexico

II. SUMMARY OF FINDINGS AND CONCLUSIONS

Summary of Findings

1. The Corps of Engineers, Albuquerque, New Mexico, is making an investigation to determine the feasibility of constructing South Berrendo Reservoir, on South Berrendo Creek in the Rio Hondo watershed, and Brady Ranch Reservoir, on the Rio Felix.

2. The study area consists of Lincoln and Chaves Counties, in southeastern New Mexico.

3. The study area had a total 1960 population of 55,393. The city of Roswell, with 39,593 persons, accounted for all of the urban population.

4. There are no heavy water-using industries in the study area; the water demand is therefore primarily municipal with small service industry use. In 1960, an estimated 45,000 persons were served by the city of Roswell's water facilities, using an average of 10.2 million gallons per day (mgd), which amounts to a per capita use of 227 gallons per day (gpcd). Roswell receives its entire water supply from 14 wells in the proximity of the city.

5. Following secondary treatment which removes approximately 80 percent of the biochemical oxygen demand (BOD), the sewage from the city of Roswell, amounting to about 4.0 mgd in 1960, is discharged to the Pecos River and/or used for irrigation. There are no significant industrial waste discharges in the area.

6. The chemical quality of surface and ground water in the study streams is generally objectionable for domestic or municipal use, but it is used for this purpose because water of better quality is not available throughout most of the region. In most cases average and maximum total dissolved solids and sulfates exceed the upper limits recommended by the Public Health Service for domestic use.

Conclusions

1. The study area is expected to reach a total population of 140,000 in 2020 with a corresponding urban population of 120,000. In 2070, the total population is expected to reach 266,000 with 250,000 urban dwellers. Much of this growth is attributed to expansion of

government activities and related trades and services.

2. Projections to the year 2020 indicate a municipal water requirement for the city of Roswell of 24.0 mgd with this increasing to 50.0 mgd by the year 2070.

3. Surface water storage to satisfy this water requirement is presently needed. The yields of the two study projects, 10.6 mgd, are sufficient to meet this demand until approximately the year 2010.

4. The use of treated waste flow from the city of Roswell for irrigation negates the need for storage in the proposed projects for water quality control in the foreseeable future.

5. The value of benefits attributable to storage for municipal water supplies, as determined by the cost of the most likely alternative to the projects, amounts to $1,083,000 annually.

6. With no foreseeable need for storage to control water quality, there is no benefit attributable to storage for this purpose.

III. PROJECT DESCRIPTION

The Corps of Engineers is studying the feasibility of constructing two reservoirs in the Rio Hondo-Rio Felix watersheds in southeastern New Mexico. Proposed South Berrendo Dam would be located at mile 11.2 on the South Berrendo Creek, some 5 miles northwest of the city of Roswell. Proposed Brady Ranch Dam would be located on the Rio Felix at about mile 13. The location of these sites is shown on figure III-1 following page X-2.

The average annual yields* of the reservoirs for municipal and industrial water supply, and water quality control purposes are 4,150 (3.7 mgd) acre-feet for the South Berrendo site, and 7,750 (6.9 mgd) acre-feet for the Brady Ranch site.

*Reservoir evaporation was accounted for in estimating reservoir yields; but seepage losses, which could be excessive, were not taken into consideration.

IV. STUDY AREA DESCRIPTION

Location and Boundaries

The study area is comprised of Lincoln and Chaves Counties located in southeastern New Mexico. General features of the Rio Hondo-Rio Felix watersheds are shown on figure III-1. The Rio Hondo subbasin covers an area of about 1,400 square miles and is approximately 85 miles long with a maximum width of 35 miles. Rio Felix subbasin comprises about 935 square miles with a length of some 65 miles, and a maximum width of 35 miles.

Geography and Topography

The topography of the Rio Hondo drainage basin ranges from an almost level alluvial plain in the east to deeply disected mountains in the west. The elevation at the confluence of the Rio Hondo and Pecos River is 3,445 feet while the Sierra Blanca Peak in the Sacramento Mountains has an altitude of 12,003 feet. 1/

Pine, spruce, cedar, juniper, and quaking aspen grow on the high hillsides, and thick grass grows in the V-shaped valleys of the mountainous areas. The central part of the basin is covered thinly by grass, weeds, cactus, and mesquite, while the eastern part is covered with grass. 1/

Climate

Summer temperatures are high in the vicinity of Roswell, however, the relative humidity is low. Temperatures may exceed 100° F. from May to September, peaking in July. The average monthly temperature ranges from 41° F. in December to 83° F. in July, with an average annual temperature of 60° F. Sunshine averages 70 percent of the amount possible for the year. 1 2/

The average annual relative humidity varies from 62 to 28 percent. The mean wind velocity ranges from 8.1 miles per hour (mph) in September to 11.8 mph in March, with an annual mean of 9.5 mph. The low relative humidity, together with the high summer temperatures and high rate of wind movements, results in a high rate of evaporation. 2/

The annual mean rainfall at Roswell is about 13 inches. 1/

Principal Communities and Industries

In 1960, the city of Roswell had a population of 39,593, which accounts for all of the urban population in the study area. Since about 1956, the oil and gas industry has developed into one of importance for the area. 3/

V. WATER RESOURCES OF THE STUDY AREA

General

Control of the water resources of New Mexico was vested in the State at an early date to assure dependable supplies to those who developed them and to prevent waste.

"New Mexico law provides that the surface and underground waters of the State belong to the public and are subject to appropriation for beneficial use. Such use is the basis, the measure, and the limit to the right to use of water, and priority in time gives the better right. The underlying principle is known as the appropriative doctrine of water rights. Where it applies, the mere physical presence of water upon or within or adjacent to land does not confer upon the owner of the land ownership of the water or even a right to its use. Rather, water rights are established exclusively through use and rights established first must be served first." 4/ Water rights in New Mexico are administered by the State Engineer.

Quantity of Water Available

Surface Water

The Rio Hondo is a perennial stream in the upper reach. All of the flow at Riverside is commonly diverted into an irrigation ditch for downstream use on the Diamond A Ranch. From Riverside to Roswell, the stream has large seepage losses and is dry most of the year. However, it is perennial in the reach from Roswell to the Pecos River because the bed of the stream is lower than the water table in the alluvium. 1/

The quantity of streamflow in the study streams was determined from period-of-record data at five stations: Rio Ruidoso at Hondo, Rio Bonito at Hondo, Rio Hondo at Diamond A Ranch near Roswell, Rio Felix at Old Highway Bridge near Hagerman, and Pecos River near Acme, New Mexico (about 13 miles northeast of Roswell). 2/ Table V-1 shows the average yearly discharges at different exceedence intervals for each of the gaging stations. The low flow conditions for water quality control requirements reflect an exceedence interval of 95 percent while water supply needs are based on a 98 percent value. The monthly distribution of uncontrolled runoff, in percent of the annual flow, for the Rio Hondo and Rio Felix subbasins and the Pecos River near Acme, New Mexico is given in table V-2.

Table V-1

Runoff Values

Location of Station	Average Annual Runoff in cfs at Various Exceedence Intervals (%)				
	98	95	90	80	50
Rio Ruidoso at Hondo	2.5	3.4	4.2	5.7	10.6
Rio Bonito at Hondo	1.4	1.7	2.0	2.6	5.0
Rio Hondo at Diamond A Ranch near Roswell	1.7	2.6	3.8	5.9	12.6
Rio Felix at Old Highway Bridge near Hagerman	0.5	1.5	2.6	4.7	12.4
Pecos River near Acme, New Mexico	69	84	98	115	158

Table V-2

Monthly Distribution of Uncontrolled Runoff

Month	% of Annual Flow			Month	% of Annual Flow		
	Rio Hondo	Rio Felix	Pecos River		Rio Hondo	Rio Felix	Pecos River
January	3	3	1	July	12	13	17
February	2	3	1	August	12	8	17
March	2	2	4	September	25	22	12
April	1	2	17	October	11	18	2
May	12	14	6	November	5	4	2
June	6	8	20	December	3	3	1

Bonito Lake was built to provide uniform diversion of 5 cubic feet per second (cfs) of water to a pipeline system that now furnishes water to the city of Alamogordo in the Tularosa basin to the south. The pipeline also collects water from the headwaters of Eagle Creek. In addition, water from the pipeline system is supplied to Fort Scanton, Capitan, Ruidoso, and a few mountain ranches.

Two Rivers Reservoir, located about 12 miles west of Roswell, is a flood-control structure with no conservation storage.

Hondo Reservoir, constructed by the Bureau of Reclamation, is an offstream reservoir which received water from the Rio Hondo. However, the reservoir was ineffective because of rapid leakage into the underlying San Andres Limestone and has since been abandoned.

The Office of Saline Water desalination plant at Roswell was placed in operation in July 1963, and provides approximately 1 mgd for the city. At the present time, the plant is not a significant source for Roswell, however, it may be expanded or put into full-time operation to augment the future water supply needs of Roswell.

Ground Water

The city of Roswell obtains its water supply from 14 wells that tap the San Andres Limestone. The wells yield 350 to 2,000 gallons per minute (gpm) each with, generally, less than 200 feet pumping levels. The water is untreated, and is pumped directly into the mains or into storage tanks. In 1960, pumpage from the wells was 10.2 mgd. Other communities using ground water for their water supply are Lincoln, and Ruidoso Downs, in the Rio Hondo watershed, and Hagerman in the Rio Felix watershed.

Ground water storage in the area has been decreasing because the total basin discharge has exceeded the recharge.

About 3,500 acres of land west of Riverside are irrigated in the Rio Hondo, Rio Ruidoso, and Rio Bonito valleys under surface-water rights, but ground water is used as a supplemental supply on 2,650 of these acres during periods of low streamflow. [1/] Water levels in the San Andres Limestone in the eastern part of the basin have been lowered, and will probably continue to be lowered requiring greater pumping lifts and inducing additional westward encroachment of saline water. (Reference is made to Chapter VII of the report for further information.) [1/]

"All ground water in the State belongs to the public and is subject to public administration, but its development and use are administered only in designated areas where such administration is deemed to be in the public interest and the interest of holders of valid water rights. The statutes provide that when the State Engineer finds the waters of an underground stream, channel, artesian basin, reservoir or lake has reasonably ascertainable boundaries, and when he so proclaims, he assumes jurisdiction over the appropriation and use of such waters." [4/] Two of these "underground-water basins" are located in the study basins; the Hondo and the Roswell artesian. The Hondo basin is situated within the upper Rio Hondo watershed (approximately above the city of Riverside) and covers about 50 percent of this upper watershed. The remaining portion of the Rio Hondo, Rio Felix, and intervening area watersheds are located within the Roswell artesian underground-water basin.

Quality of Water Available

Surface water

The chemical quality of surface water in the Rio Hondo watershed is generally satisfactory for irrigation and stock use, except in the eastern part of the basin. Locally, as in the upper reaches of the tributaries, surface water is satisfactory for municipal use. Characteristic analyses of grab samples taken from streams in the Rio Hondo and Rio Felix subbasins are given in table V-3.

Table V-3

Characteristic Analysis of Streamflow in the Study Subbasins

Stream [a]		Number of Samples[b]	Spec. Cond. (micromhos at 25°C)	Total Dissolved Solids (mg/l)	Sulfates (mg/l)	Chlorides (mg/l)
Rio Bonito						
	Max.	20	1890	778	783	122
	Min.		308	188	83	9.5
	Ave.		1195	356	480	52
Eagle Creek						
	Max.	5	611	157	152	24
	Min.		208	144	45	6.2
	Ave.		326	150	74	12
Rio Ruidoso						
	Max.	14	2040		975	73
	Min.		174		41	6.5
	Ave.		1277	105	537	48
Rio Hondo						
	Max.	33	1970	1740	965	71
	Min.		414	382	200	6.0
	Ave.		1327	935	722	40
Rio Felix				[c]		
	Max.	3	8330		1850	1850
	Min.		6550		1830	1460
	Ave.		7230		1840	1610
PHS recommended upper limit for domestic use				500	250	250

[a] Samples taken from various locations along the stream.
[b] In some cases the number of tests of the individual characteristic is less than the number of samples.
[c] Data not available.

Source: New Mexico State Engineer [1]

Based on the Bureau of Reclamation Reconnaissance Report on the Pecos River, dated June 1960, approximately two-thirds of the annual flow in the Pecos River near Roswell (between 1938 and 1955) was releases from Alamogordo Reservoir. The highest dissolved solids concentrations at the gaging station just below Alamogordo Dam probably represent the average concentrations of the reservoir water at that time. Highest concentration of dissolved solids reported in water year October 1953 to September 1954 was 2,730 milligrams per liter (mg/1), and the lowest was 1,250 mg/1. 6/

During the period-of-record, October 1937 through September 1955, the concentration of dissolved solids in the Pecos River near Artesia, New Mexico (about 40 miles south of Roswell) varied from 479 mg/1 to 14,000 mg/1, with a flow weighted mean value of 2,743 mg/1.

Ground Water

Ground water in the extreme eastern part of the Rio Hondo basin is highly saline. In 1958, the chloride content of the water in wells ranged from 500 mg/1 near the eastern limits of Roswell to more than 5,000 mg/1 near the Pecos River, east of Roswell. 4/ Because large amounts of water from the San Andres Limestone have been used for irrigation in the Roswell artesian basin, the hydraulic gradient from Roswell to the saline water near the Pecos River has been reduced. This action results in saline water encroachment in the ground water near Roswell.

If pumping continues at a rate that substantially exceeds recharge, lands close to the Pecos River may have to be taken out of production because of the salinity of the irrigation water. If sufficient land is withdrawn from irrigation to create a balance of demand and recharge, the westward movement of the saline water wedge may be stabilized or even reversed. It has been reported that in an effort to decrease the demand, the Pecos Valley Artesian Conservancy District has made considerable expenditures in the past few years to purchase the water rights of irrigated lands and to retire such lands from irrigation. Other plans are available to alleviate this situation. Pumping saline water from the source area would lower the artesian head in the source area and slow down or stop the movement of saline water toward Roswell. The practice of substituting crops having a smaller duty of water along with more efficient irrigation practices would aid in this respect. Also, artificial recharge to the San Andres limestone west of Roswell would inhibit encroachment. Finally, a combination of all or part of these methods could be employed.

More recent investigations of this problem suggest the cause may be attributed to upward leakage of the saline water from the lower parts of the San Andres, Glorieta sandstone and lower formations. 7/ If

vertical leakage rather than primarily horizontal movement is the case, a balance of demand and recharge, by retirement of water rights as discussed in the above paragraph, would probably be the most feasible method of correction.

The chemical quality of ground water elsewhere in the basin is generally satisfactory for irrigation and stock use. The ground water is generally objectionable for domestic or municipal use, but it is used for these purposes because water of better quality is scarce throughout most of the region. 1/ Chemical analyses of water from wells in the principal geologic formations in the Rio Hondo basin are shown in table V-4. Maximum, minimum, and mean values for each characteristic are given for the alluvium, Yeso Formation, Hondo Sandstone member of the San Andres limestone, and upper part of the San Andres limestone. Generally, the concentration of sulfates and dissolved solids in the ground water exceeds the upper limits of 250 and 500 mg/l, respectively, recommended in the U.S. Public Health Service Drinking Water Standards. 8/

The Yeso Formation underlies, at varying depths, most of the Hondo basin, and crops out in the valleys of the Rio Ruidoso, Rio Bonito, and Rio Hondo west of Riverside. In the vicinity of Roswell, the top of the formation is about 1,000 feet below the land surface. The Hondo sandstone, member of the San Andres Limestone, underlies, at varying depths, most of the Hondo basin. The upper part of the San Andres limestone is exposed from 3 miles to 60 miles west of Roswell and underlies the eastern part of the Hondo basin. The alluvium is primarily located in the eastern part of the basin and in the main stream valleys.

Table V-4

Characteristic Analysis of Ground Water
from Principal Aquifers in the
Rio Hondo Watershed

Characteristic	Alluvium a/ Concentration (mg/l)			Yeso b/ Concentration (mg/l)			Upper Part of San Andres Limestone c/ Concentration (mg/l)			Hondo Sandstone Member of San Andres Limestone c/ Concentration (mg/l)		
	Max.	Min.	Mean e/	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Calcium (Ca)	-	-	272 (1)	362	187	267 (4)	250	106	165 (10)	-	-	82 (1)
Magnesium (Mg)	-	-	78 (1)	90	62	79 (3)	66	36	51 (10)	-	-	29 (1)
Sodium and Potassium (Na & K)	40	12	25 (3)	59	11	32 (6)	66	9.7	31 (10)	16	6.7	12 (3)
Bicarbonate (HCO_3)	300	164	241	285	128	215	323	171	242	278	148	215
Carbonate (CO_3)	0	0	0	0	0	0	11	0	1	0	0	0
Sulfate (SO_4)	796	511	691	2095	245	820	765	94	337	617	109	228
Chloride (Cl)	67	38	53	99	22	61	340	14	61	98	14	29
Fluoride (F)	d/	d/	d/	2.0	0.1	1.1 (7)	-	-	0.1 (10)	-	-	0.5 (1)
Nitrate (NO_3)	7.4	4.0	5.8 (3)	5.0	0.1	1.9 (7)	15	0.4	5 (10)	5.7	2.8	4.3 (3)
Dissolved Solids	-	-	1420 (1)	1530	1100	1235 (4)	1270	1120	1195 (2)	-	-	419 (1)
Hardness (as $CaCO_3$)	1080	690	925	2440	432	1036	1050	316	585	830	301	431
Specific Conductance (micromhos @ 25°C)	1820	1260	1605	3250	811	1691	2130	580	1160	1570	584	819
pH (pH units)	7.7	7.2	7.5	8.2	7.1	7.4	7.6	7.2	7.4 (10)	8.2	6.9	7.5

a/ Data from 13 wells; b/ Data from 24 wells; c/ Data from 21 wells: d/ Data not available
e/ Figure in parenthesis following the mean value indicates the number of tests performed for the correspond.ng characteristic, when different from the total number of samples.
Source: New Mexico State Engineer 1/

VI. THE ECONOMY

An economic study was made of the study area and the resulting projections of population and industrial growth serve as a basis for estimating future water use requirements and waste discharges.

Present

Economic Geography

The study area consists of Chaves and Lincoln Counties in the semiarid climate of southeastern New Mexico. The 1960 population of the study area was 65,393 persons, increasing over 100 percent since 1940. The city of Roswell, at an altitude of 3,600 feet, is the principal center of population in a large trade area. Roswell had a 1960 population of 39,593, and was responsible for 80 percent of the increase for the study area during the past two decades. Ruidoso Downs Race Track, Sierra Blanca Ski Area (16 miles from Ruidoso), Mescalero Apache Reservation, and mountain and forest areas nearby attract thousands of people to the resort community of Ruidoso (altitude of 6,900 feet).

Resources Within the Area

In addition to the healthful climate, the study area is surrounded with recreation areas and items of historic interest. The area is served by two railroad lines, four national highways, two airlines, and major bus and truck lines.

In 1959, a total of 95,500 acres were irrigated in the study area. Since about 1956, the oil and gas industry has developed into one of major importance in Chaves County. Also, logging on the Capitan and Sacremento Mountains supports several sawmills. 3/

Manufacturing

Manufacturing is relatively insignificant in the study area, employing less than 6 percent of the 1960 labor force. 9/ No heavy water-using industries are located in the study area at the present time.

Other Industries in the Area

Employment growth from government activities has been particularly significant. In 1961, Walker Air Force Base, which is located about three miles outh of the city of Roswell, had 5,528 assigned military personnel and 360 civilian employees. Other Federal government installations in the area are Atlas missile sites, and a model water desalinization plant at Roswell.

The increase in public employment and spending in the area accounts for much of the growth, either directly or indirectly, of the construction, trade, services, and other related industries. Construction and service industries, which include public employment, are the most significant employers in the area, accounting for 10 percent and 61 percent, respectively, of the total labor force in the study area in 1960. 10/

Future

The Department of Defense ordered Walker Air Force Base to cease operations by July 1967. The long-range effect of this action on the growth of Roswell is expected to be insignificant. Certainly, many service-oriented businesses and industries having direct relation to the base will suffer some initial damage. However, the diversity of resources available should permit the Roswell area to adjust and absorb this economic loss within a short time.

Since there is no heavy water-using industry in the area at the present time and no basis on which to anticipate the development of this type industry, projections of population are relied on as an indicator of future water use. The public sector of the economy is expected to remain important to the economy of the area, with the expansion of the public sector in the fields of manufacturing, mining, trade, services, and agriculture to provide a more balanced economy.

Historic and projected populations for the study area and the city of Roswell to 2070 are shown in table VI-1.

Table VI-1

Historic and Projected Population for the Study Area and City of Roswell, 1930-2070

	Historic			Projected	
	Study Area	Roswell		Study Area	Roswell
1930	26,747	11,173	1980	85,000	59,000
1940	32,537	13,482	2000	110,000	87,000
1950	48,014	25,738	2020	140,000	120,000
1960	65,393	39,593	2070	266,000	250,000

Source: Historic, Bureau of the Census 10/

VII. WATER REQUIREMENTS

Past and Present Water Use

Roswell receives its water supply from 14 wells in the proximity of the city. Water usage by Roswell was 6.5 mgd in 1950, and 10.2 in 1960. These demands include service industries and, as discussed in Chapter VI, there are no heavy water-using industries in the community.

Future Requirements

Future water requirements for the city of Roswell are based on population projections presented in Chapter VI and a unit water use of 200 gpcd in 2020 and 2070. Per capita water use in Roswell increased from 186 gpcd in 1940 to 227 gpcd in 1960. However, over 30 percent of the 1960 water use was classified as "Public and Other" and includes leakage and unaccounted for water. The high percentage in this category indicates an above normal water loss in the distribution system. Future conditions reflect a slight increase in domestic, commercial, and industrial water use although the total per capita use is expected to be lowered as water losses are minimized. This rate of water use is intended to include both municipal and service industries, and reflects the economic character of Roswell with no large users of water anticipated in the future.

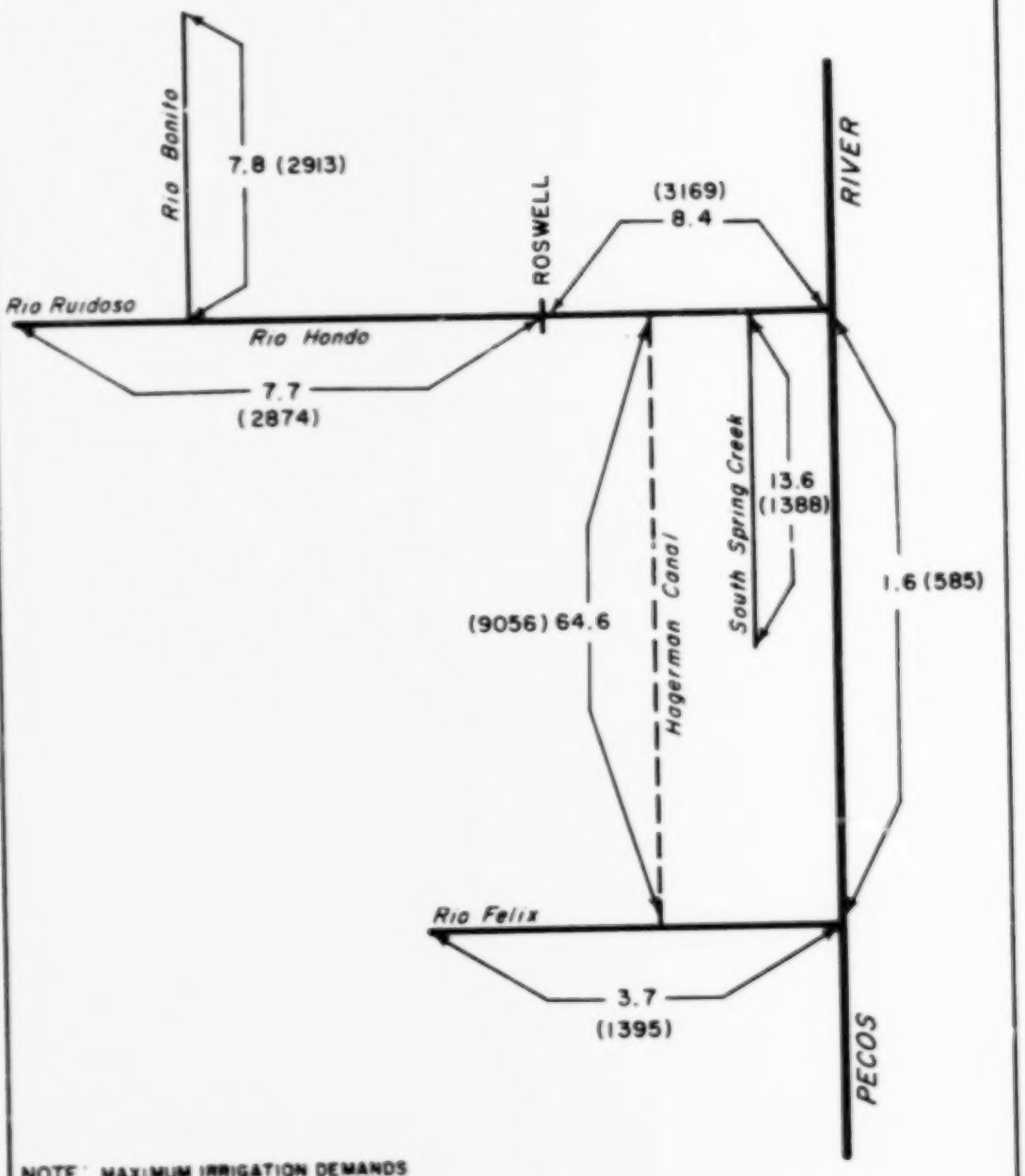
The water requirements of Roswell are expected to be 24.0 mgd in 2020, and 50.0 mgd in 2070.

Another important water use in the study basins is irrigation, which represents a considerable portion of the demand on the water resources of the area. The maximum water demand for this purpose in the two basins and the intervening area between the basins and the Pecos River is about 120,000 acre-feet per year or 107 mgd. These values were determined by the Corps of Engineers based on existing commitments and a maximum water duty of 2.5 to 3.0 acre-feet per acre. Figure VII-1 is a schematic diagram showing the general allocation of these demands and the irrigated acreage in the area.

With present pumpage and recharge rates, the water table in the San Andres limestone in the eastern part of the Hondo basin can be expected to decline at a rate of one and one-half to two feet per year. 1/ Therefore, surface water storage to satisfy municipal and industrial water needs for the city of Roswell is presently needed. The yields of the two study projects, 10.6 mgd, are sufficient to meet these demands until approximately the year 2010.

As ground water levels are lowered in the watershed, irrigation in the watershed will probably become less economical. Since municipal and industrial users can afford to pay more than agriculture

can for water, it appears that ground water, with treatment to improve quality, will be used to satisfy requirements of Roswell beyond the year 2010. Since present irrigation rates in the study basins far exceed the foreseeable municipal and industrial needs of Roswell, the community's requirements could be satisfied by decreasing irrigation use. To implement a plan of this nature would require considerable field study as well as thorough management of the ground water resources in the influenced area.



NOTE: MAXIMUM IRRIGATION DEMANDS ARE IN MILLION GALLONS PER DAY. FIGURES IN PARENTHESIS ARE IRRIGATED ACREAGE.

WATER SUPPLY & WATER QUALITY CONTROL STUDY
RIO HONDO-RIO FELIX SUBBASINS
PECOS RIVER BASIN-NEW MEXICO

SCHEMATIC DIAGRAM OF MAXIMUM WATER DEMANDS FOR IRRIGATION

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
SOUTH CENTRAL REGION MAR 1, 1968 DALLAS, TEXAS
REV AUG 5, 1968

FIGURE VII-1

VIII. WATER QUALITY CONTROL

General

Water quality control is defined as any measure employed to enhance the utility, value, and attractiveness of waters used for purposes which are affected by changes in water quality. The use of water by man in his many activities and the subsequent return of waste effluent even after secondary treatment, causes some degradation of water quality. As population and the associated water demand increases, the problem caused by waste water becomes more significant. If the quality of the stream receiving this treated waste is reduced below acceptable limits, additional water of better quality is necessary to correct this condition. This report is concerned with the possible use of releases from South Berrendo and Brady Ranch Reservoirs on water quality in the Pecos River.

Water Quality Objectives

Of the indicators presently available as measures of water quality, dissolved oxygen and total dissolved solids were selected as the water quality objectives of this study. Dissolved oxygen is used to measure the effect of organic pollutants (those constituents which will, with time, decompose in the stream), as appraised by biochemical oxygen demand (BOD). Dissolved oxygen is a significant factor in maintaining an environment for propagation of fish and other aquatic life. A lower limit of 4 mg/l of dissolved oxygen was used since (1) it provides an acceptable environment for most aquatic life native to this area, and (2) it provides a buffer zone in the event unforeseen spills of waste occur. Dissolved solids are employed to characterize the effects of stable pollutants (those constituents which are not utilized or reduced by the stream environment), such as chloride and sulfate salts.

Presently, use of water from the Pecos River in the affected reach of the stream is for irrigation. There are no anticipated municipal and/or industrial water users. Because of this, total dissolved solids (TDS) are not considered a problem at the concentrations found in this area. Also, because of the quantity and high dissolved solids concentration of the flow in the Pecos River, as discussed in Chapter V, dilution releases from the projects for this

purpose would have only a small effect on quality of the river. Therefore, consideration of storage for water quality control is for fish and wildlife, recreation, and aesthetic purposes.

Municipal and Industrial Pollution

At the present time (1960), the average return flow of Roswell is about 4 mgd with a population equivalent (P.E.) of approximately 7,500. 11/ The return flow is expected to increase to about 15 mgd in 2020, and 27 mgd in 2070. The projected municipal and industrial return flow of Roswell was estimated to be 55 percent of the water use and have an untreated ultimate BOD of 270 mg/l. Future water quality control requirements are based on the assumption that sufficient treatment of waste flow will remove 90 percent of the BOD. Since water in this area of the country is scarce, it is reasonable to expect this degree of treatment to obtain maximum use from the resources available.

Flow Regulation

Effluent from the Roswell sewage treatment plant is presently used for irrigation and/or discharged to the Pecos River above the confluence with the Rio Hondo. Periods of low streamflow, when the critical stream quality conditions develop, coincide with maximum water demands for irrigation in the future. Normally, irrigation is practiced about eight months of the year, the average frost-free period for this area being from April 8 to November 2. However, in years of low precipitation, winter irrigation or pre-irrigation may be necessary before crops are planted. 12/ For these reasons, future return flow during low flow conditions is expected to be used for irrigation and releases from the study reservoirs for organic water quality control purposes are not needed in the foreseeable future.

In the event the waste flow from Roswell is not used for irrigation in the future, e.g., in the winter months, the pollutional effects of discharging the waste to the Pecos River was investigated. In this evaluation, monthly dissolved oxygen concentrations were determined for the maximum condi ion (2070). Based on this study, the dissolved oxygen concentration in the river is not degraded below 4 mg/l.

IX. BENEFITS

Water Supply

The benefits of developing South Berrendo and Brady Ranch Reservoirs result from the provision of a dependable water supply. In addition, the existence of these reservoirs would offer recreation such as swimming, fishing, boating, camping, and water skiing for those living in and near the study area. The sale of goods and services associated with these facilities would become a significant segment of the economy of the area. Also, property values in the vicinity of the impoundments would be improved. Finally, municipal and industrial water users would be provided a supply of more uniform physical and chemical quality, with proper operation of the reservoirs.

Senate Document No. 97 (87th Congress, 2nd session) makes the following statement concerning evaluation of benefits of municipal and industrial water supply storage in Federal reservoirs:

> "The amount water users should be willing to pay for such improvements in lieu of foregoing them affords an appropriate measure of this value. In practice, however, the measure of the benefit will be approximated by the cost of achieving the same results by the most likely alternative means that would be utilized in the absence of the project."

Several alternative systems to provide municipal and industrial water supply were considered and are explained below.

The Bureau of Reclamation has recently completed a study which evaluated the feasibility of supplying water to 17 eastern New Mexico cities, including Roswell, from existing Ute Reservoir on the Canadian River near Logan, New Mexico. 13/ Ute Reservoir was constructed by the State of New Mexico and has a dependable yield of 50,000 acre-feet per year. In this report, 12.5 mgd was allocated to Roswell by prorating the total reservoir yield on the basis of the participating cities' use in 1962. Using a 50-year repayment period, the cost to Roswell amounted to 32 cents per thousand gallons, which includes an operation and maintenance rate of 9 cents, plus a 3 cent charge for water from the reservoir. To be consistent with the time period used for calculating benefits for other uses of the water in the project reservoirs, the capital cost of the Ute project ($20,313,500) was amortized over 100-years at an interest rate of 3 1/8 percent and added to the annual 12 cents charge to give a total cost of 28 cents per 1,000 gallons. The annual cost to yield 10.6 mgd, the combined yield of the projects, amounts to $1,083,000. Although the yields of the projects and this system are not identical, they are close enough for comparison purposes. It should be noted that the above cost figures

are dependent on all of the cities participating in this program, as members of the Eastern New Mexico Inter-Community Water Supply Association.

As stated in Chapter III, the dependable yields of the study projects do not reflect seepage losses. Since these reservoirs would be underlain by highly porous soil, the Corps of Engineers estimates that this loss could be quite substantial, as evidenced by existing reservoirs located nearby and on this same geological formation. It is possible that, much of the time, the projects would function only as a means of recharge to the ground water storage in the area. While the Corps has investigated numerous methods to seal reservoirs of this type in the area, they were not considered to be either effective or engineeringly feasible. Therefore, the costs of single-purpose reservoirs at the proposed sites as an alternative was not developed.

Modification of existing Two Rivers Reservoir on Rio Hondo to yield an additional 10.6 mgd was investigated. Again the uncertainity of the reservoir's capability to store water over a period of time, prevents its use as an alternate.

Since ground water levels in the Roswell area are presently being lowered, use of this resource for water supply purposes was not considered feasible. The high cost of "desalting" waters, at the present time, from the Pecos River prohibit employing this plan.

The value of benefits attributable to storage in Brady Ranch and South Berrendo Reservoirs for municipal water supply, as determined by the costs of the most likely alternatives to the projects, amounts to $1,083,000.

Water Quality Control

Since there will be no foreseeable need for storage to control water quality, as discussed in Chapter VIII, there will be no benefits attributable to this purpose.

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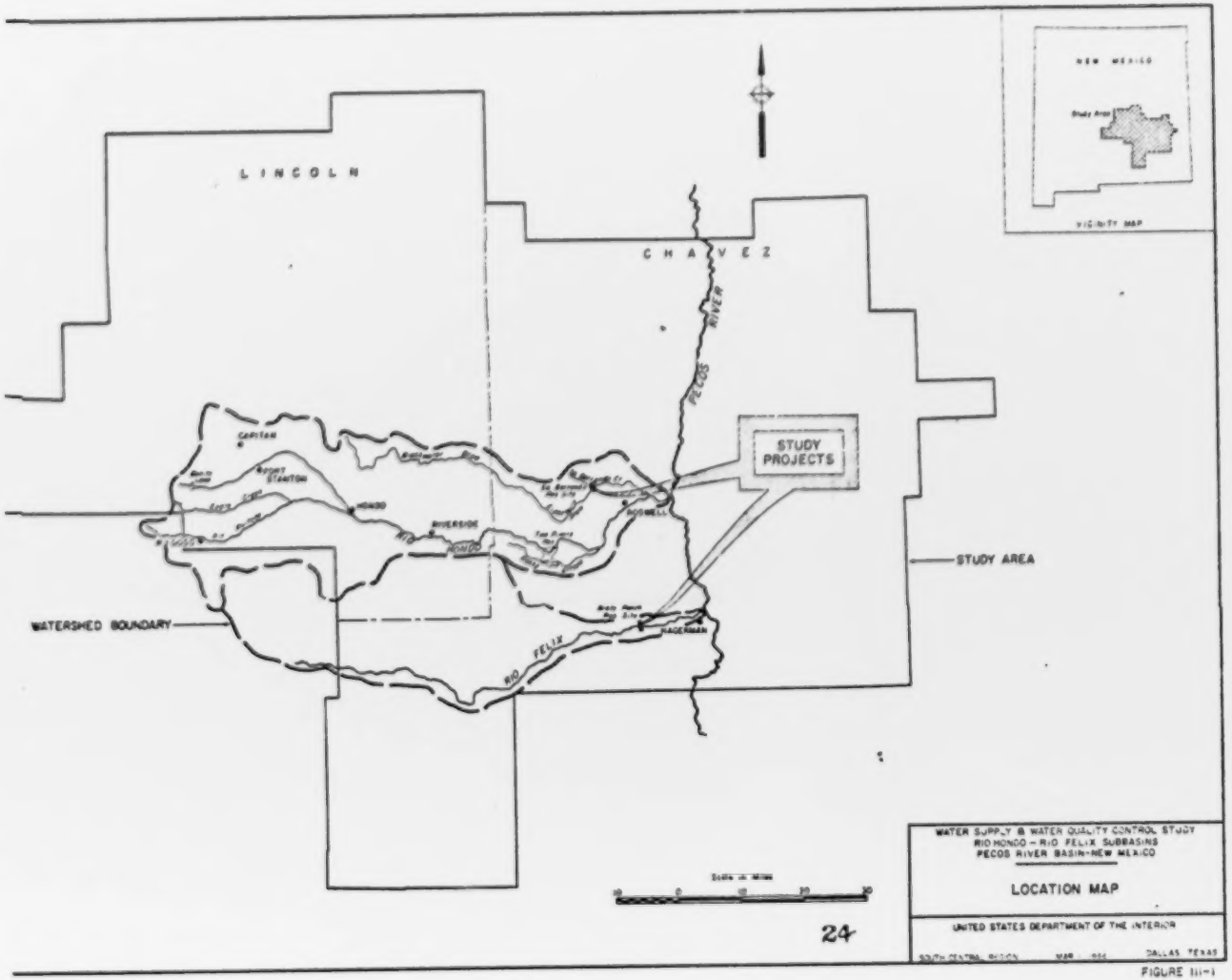
LINCOLN
CHAVEZ
PECOS RIVER
STUDY PROJECTS
STUDY AREA
WATERSHED BOUNDARY
RIO FELIX
NEW MEXICO
VICINITY MAP
WATER SUPPLY & WATER QUALITY CONTROL STUDY
RIO HONDO - RIO FELIX SUBBASINS
PECOS RIVER BASIN-NEW MEXICO
LOCATION MAP
UNITED STATES DEPARTMENT OF THE INTERIOR
SOUTH CENTRAL REGION
DALLAS, TEXAS
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FIGURE III-1